

## Office Work in the Context of Rapidly Developing Information Technology: Better Ergonomics Needed to Limit Stress

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**Abstract.** Advances in information technology have triggered changes in the way work is done at VDTs. Traditional patterns of office work have also been changing accordingly, with mobile work being a typical example. We conducted a series of studies to examine the current state of VDT work and identify any new occupational safety and health issues. Our results suggest that new patterns of office work, if made to fit the latest information technologies, can lead to mental ill health, but that this downside can be counteracted by adopting organizational and ergonomic improvements.

**Keywords.** Information technologies, Free address system, Burnout.

### 1. Introduction

Advances in information technology have prompted changes in VDT (Visual Display Terminal) work. Larger displays or FPDs (flat panel displays) are very popular now; people use different types of input devices; notebook computers have become smaller. As a result of such advances, traditional patterns of office work also have been changing. Mobile work is the one of the clearest examples of this.

When environments are changing rapidly, however, it is easy to fail to notice their unintended drawbacks and not to establish monitoring systems to detect potential risks.

To examine the current state of VDT work and to find solutions if there are any new occupational safety and health issues, we conducted a series of surveys. In this report, we focused on the so-called “free address system” and contrast it with traditional VDT work (referred to as “fixed address work”). Free address environments are defined as “a variety of different workspaces and no permanently assigned office or

workstations where workers select the setting that suits their activity at the moment (IFMA, 2004).”

### 2. Subjects and Methods

We conducted a survey on i) workers at member companies of the Japan Facility Management Promotion Association (JFMA) (Study 1) and ii) workers at an IT company which has adopted the free address system (Study 2).

#### 2.1. Study 1

This survey was designed to take a snapshot of current Japanese office work with special reference to computer use. In total 6,580 self-administrated questionnaires were handed out. One fifth of the questionnaires (1,302) were distributed to individual JFMA members. Two questionnaires were sent to each, and we requested him/her to answer the questionnaire as well as to ask one more person to participate the survey. For the JFMA member companies, questionnaires were distributed through a person in authority. In most companies, this person selected up to 30 participants and asked them to answer the questionnaire. The participants returned the questionnaire, sealed in an envelope, to the person responsible at each company, who then returned the questionnaires to us. Table 1 shows the response rate for individual members and member companies.

**Table 1 Respondent rate for Study 1. JFMA individuals and individual companies.**

Category	Number of individuals involved	Number of questionnaires sent to each individual	Number of distributed questionnaires in total	Number of individuals responding (Response rate)	Number of returned questionnaires (Response rate)
Individual	651	2	1,302	265 (40.7)	415 (31.9)
Company member	169	30*	5,278	111 (65.7)	1,959 (37.1)
Total	-	-	6,580	-	2,374 (36.1)

\* In some cases, the number of questionnaires was larger or smaller. For most of the companies, 30 questionnaires were sent.

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**Table 2 Distribution of selected items related to the characteristics of the participants: Study 1.**

Items	Male (n=1741)	Female (n=622)	%
<b>Age distribution</b>			
20-29	13.6 (236)	48.2 (263)	
30-39	31.0 (538)	38.3 (235)	
40-49	27.4 (476)	12.5 (77)	
50-59	23.2 (404)	6.0 (37)	
60-	4.8 (84)	0.3 (2)	
<b>Job Title</b>			
Clerical staff	26.7 (458)	71.4 (440)	
Sales and marketing	15.0 (257)	2.9 (18)	
Research and development	7.5 (128)	2.1 (13)	
Executive	22.4 (385)	2.8 (17)	
Designer	17.8 (306)	14.6 (90)	
Systems engineer	4.6 (79)	0.8 (5)	
Customer services	1.6 (28)	1.1 (7)	
Others	4.4 (75)	4.1 (25)	
<b>Teleworking</b>			
Teleworker	1.8 (30)	4.5 (27)	
<b>Mean Duration of Employment</b>			
-2	19.9 (274)	21.3 (103)	
2-5	27.9 (383)	33.5 (162)	
6-10	19.4 (266)	24.2 (117)	
11-20	19.7 (271)	18.6 (90)	
21-	13.1 (180)	2.5 (12)	

The questionnaire focused on working conditions and environments related to computer use, psychosocial conditions, physical conditions and mental conditions. We developed most of the questions ourselves, but for questions on mental condition, we used the “Burnout scale” which was first developed by Pines *et al.* and the “Tedium Scale” to examine physical, emotional and mental exhaustion (Pines *et al.*, 1981). We used a modified Japanese version developed by Doi *et al.* (Doi *et al.*, 1988).

For data analysis, we looked at the relationship between working conditions and the environment or psychosocial conditions and physical or mental health.

## 2.2. Study 2

This study was designed to examine the effect of the free address system on workers' health. We distributed almost the same questionnaire as in Study 1 to systems engineers using the free address system, systems engineers using the fixed address system, and designers (fixed address) in an IT company.

Four hundred and forty-five questionnaires were distributed and 335 workers responded (response rate: 75.3%). Workers who gave incomplete information were excluded.

Of 285 male respondents, 164 were systems engineers using the free address system, 94 were systems engineers using the fixed address system and 27 were designers. Female respondents were excluded because of their small sample number. The data was analyzed to compare the ergonomic

environment, working conditions, psychosocial conditions, physical health and mental health among the 3 different work patterns.

## 3. Results

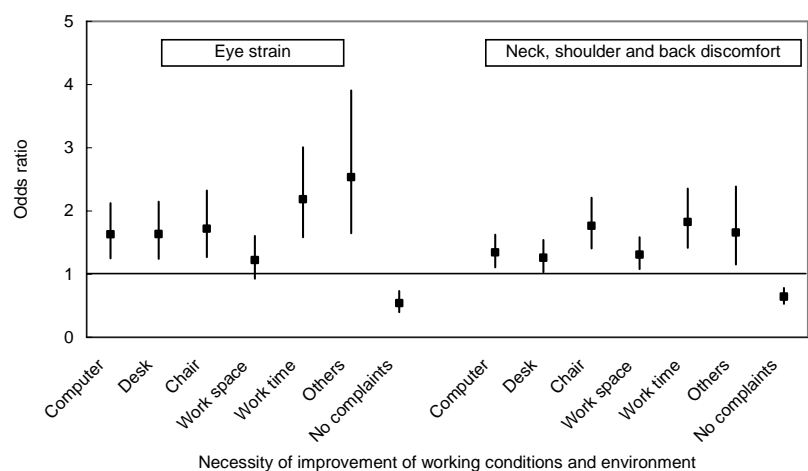
### 3.1. Study 1

#### 3.1.1. Characteristics of the participants

Table 2 shows the characteristics of the respondents. The age distribution among male participants was varied but most female respondents were under 40. Of the male participants, clerical staff composed the largest group, followed by executives, designers and sales and finally marketing staff. Of the female participants, the proportion of clerical staff was above 70%. Duration of employment among male participants was equally distributed among different categories except for the category of 2-5 years. Duration among female participants was shorter than for the males, which reflected their younger age distribution.

#### 3.1.2. Working conditions and environment and the physical and mental health of office workers

Figure 1 shows the relative risks of eye strain and musculoskeletal discomfort (neck, shoulder and back strain). Compared to workers who did not feel any need for improvement of their working conditions and environment, the prevalence of eye strain and musculoskeletal discomfort was significantly higher among workers who felt that their working conditions and environment needed to be improved. Regarding eye strain, the relative risk was highest among workers who felt the need for shorter working hours, followed by better chairs, desks and computers. Relative risks for musculoskeletal discomfort were also high among workers who expressed the need for shorter working hours and better-designed chairs. For both eye strain and musculoskeletal discomfort, prevalence was significantly low among workers who were satisfied with their working conditions and working environment.



**Figure 1 Inadequate working conditions and environment may cause ill health in workers.**

Black squares and vertical lines are odds ratios and 95% confidence intervals for subjective symptoms by necessity of improvement of working conditions and environment.

It was interesting to note that even an ergonomically favorable working environment could lead to burnout (Figure 2). The mean burnout score was the highest among workers who felt the need for shorter working hours, rising to more than 5 points, reflecting a seriously exhausted state, among workers who also complained about their desks and chairs.

The score was significantly lower among workers with no complaints about their working conditions or working environment.

Figure 3 suggests that the state of burnout is related to psychosocial conditions. Notably, items related to job satisfaction (items 8 and 9) and job control (items 4, 5, 6 and 10) showed very strong and clear relationships with burnout score.

### 3.2. Study 2

#### 3.2.1. Characteristics of the participants

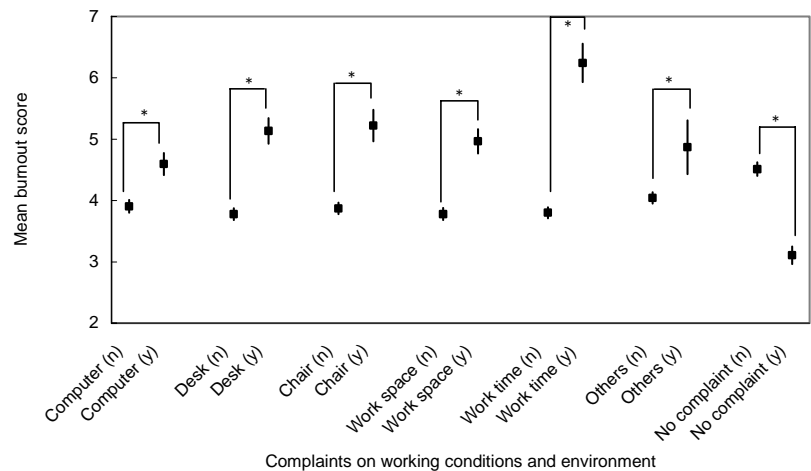
Table 3 shows the age distribution and duration of employment of the participants. Compared to the participants in Study 1, they are older and have worked longer. As for the systems engineers, those using the free address system are slightly younger and have worked for a shorter period.

#### 3.2.2. Comparison of complaints about working conditions and working environment

The pattern of complaints varies according to type of work (Table 4). Among the designers, the prevalence of complaints about working conditions and environment was very high except for complaints about work time. Compared to systems engineers using the fixed address system, the prevalence of complaints concerning workstations, such as desks, chairs and workspace, was lower among those using the free address system. Complaints about computer quality and work time were high among the systems engineers using the free address system.

#### 3.2.3. Comparison of psychosocial conditions

Psychosocial conditions also varied according to the type of work. Table 5 shows responses to questions on the



**Figure 2 Inadequate working conditions and environment may be relevant to burnout.**

Comparison of mean burnout score by complaints on working conditions and environment. Black squares and vertical lines show mean values and standard errors of burnout score. A T-test was performed to compare the values between workers having complaints and those not having complaints (\*  $p < 0.05$ ).

psychosocial condition of the participants. Responses from systems engineers using the free address system were negative for many items. Responses from the designers were more positive or similar to those from systems engineers using the fixed address system.

#### 3.2.4. Comparison of subjective symptoms

The systems engineers using the free address system showed a high prevalence of subjective symptoms, although the relative risks (odds ratios) compared with those using the fixed address system were mostly not statistically significant (Table 6). Only the prevalence of physical or mental fatigue was significantly high, reaching twofold. Symptoms resulting from eye fatigue were particularly high among designers.

#### 3.2.5. Comparison of burnout scores

Figure 4 shows burnout scores for 3 different types of work as well as the result of a previous study on health care workers done by Doi *et al.* in 1985. For each job category of the participants in the present study, the proportion of workers showing high burnout scores (more than 5 points) was higher than that of health workers. It was particularly high, reaching more than 60%, among systems engineers using the free address system, whereas it was around 30% among nurses, whose work is known to be particularly stressful.

## 4. Discussion

### 4.1. Working conditions and the working environment for office workers and their health

In the field of occupational safety and health, everyone knows that working conditions and the working environment can affect workers' health. Although it has been known since the early 18<sup>th</sup> century that sedentary work could be hazardous, experts in this field more or less ignored the risks of office work until VDT work became common.

Due to advances in information technology, the

**Table 3 Distribution of selected items related to the characteristics of the participants: Study 2.**

Items	SE(Fixed) (n=93)	SE(Free) (n=164)	Designer (n=27)
<b>Age distribution</b>			
20-29	20.4 (19)	18.9 (31)	25.9 (7)
30-39	39.8 (37)	64.6 (106)	48.1 (13)
40-49	32.3 (30)	12.8 (21)	25.9 (7)
50-59	7.5 (7)	3.7 (6)	-
<b>Mean duration of employment</b>			
-2	13.3 (12)	11.9 (19)	13.6 (3)
2-5	12.2 (11)	11.3 (18)	-
6-10	12.2 (11)	20.0 (32)	27.3 (6)
11-20	40.0 (36)	46.9 (75)	45.5 (10)
21-	22.2 (20)	10.0 (16)	13.6 (3)

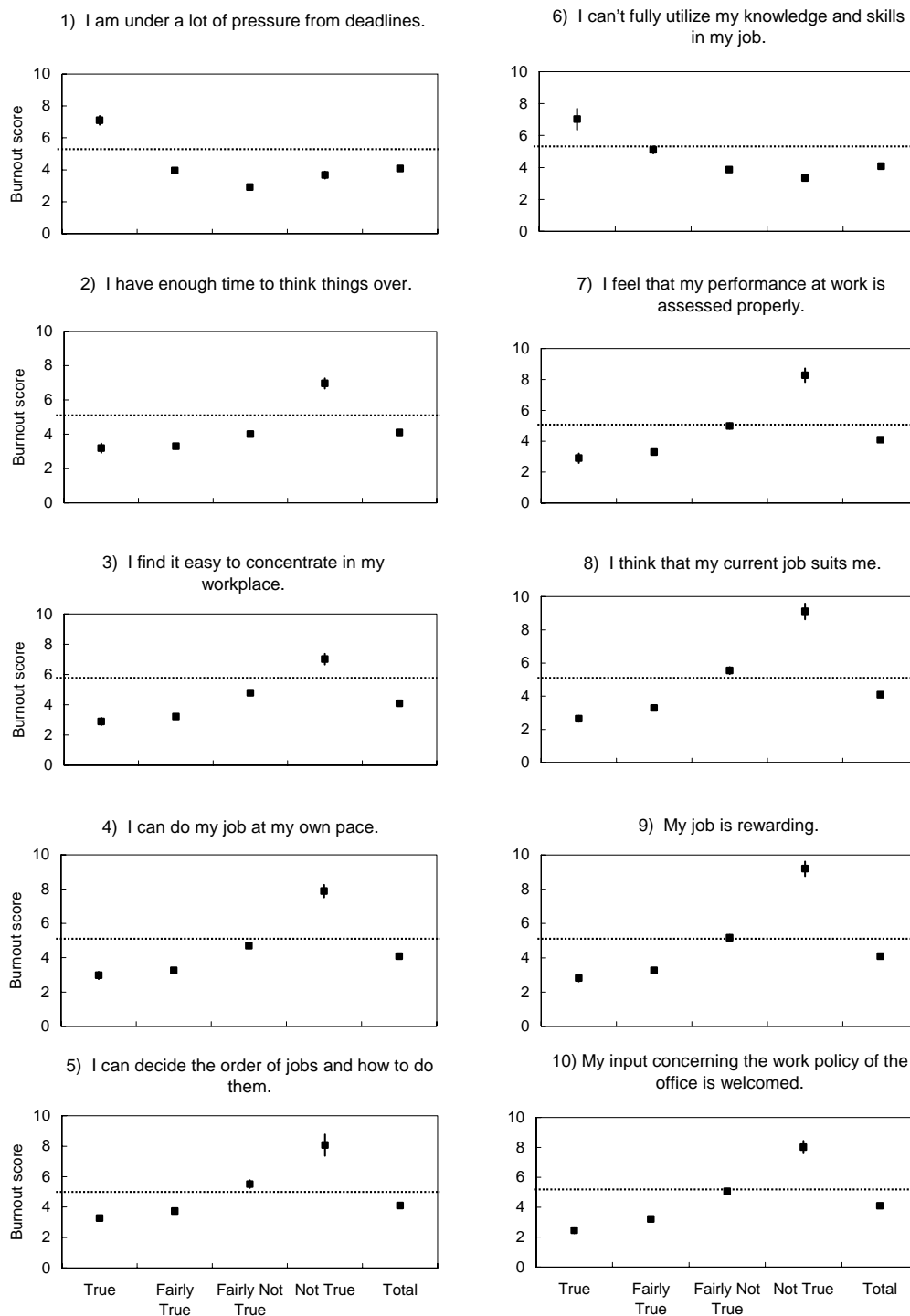


Figure 3 Association between selected psychosocial conditions and burnout score.

vast majority of office workers are now involved in VDT work. Furthermore, faster computers, larger displays and more sophisticated software are being introduced in offices to improve efficiency and productivity. When newer technology is hastily introduced into the workplace, however, it is important to remain aware of its potential adverse effects on workers' health.

The results of Study 1 show that working conditions and the environment in office work are important to workers'

health. The score indicates the prevalence of subjective symptoms was high among workers, who frequently complained about their working conditions and working environment. This result suggests that improvement of the office environment can contribute to healthier working patterns of office workers.

#### 4.2. Even office staff work under very stressful conditions

Analysis of psychosocial conditions and burnout score showed striking results. Many office workers were thought to be in a highly burned out state, and it was very clearly relevant to their psychosocial condition. Needless to say, management of working conditions and comradeship are crucial to ease stressful conditions, but a better office environment can also help. Lower burnout score among workers with fewer complaints about working conditions and environment appears to support this idea.

#### 4.3. The free address system—does it reduce the stress of office work?

Prior to the present studies, we interviewed several workers in various forms of office work and became aware of a unique style known as the "free address system". In Japan, this system is

recommended for the purpose of reducing costs. It makes it possible to reduce the number of desks and chairs and thus to utilize office space more efficiently.

On the other hand, we have identified several drawbacks resulting from the introduction of a free address system. One Japanese facility manager, a professional who encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and

**Table 4 Comparison of complaints on working conditions and environment: Study 2.**

	Prevalence of complaints (n)	Odds ratios and 95% confidence intervals*
<b>I want to improve the quality of my computer.</b>		
SE (Fixed)	40.4 (38)	1.0
SE (Free)	49.4 (81)	1.4 (0.8– 2.5)
Design	74.1 (20)	4.2 (1.5–12.3)
<b>The quality of my desk should be higher</b>		
SE (Fixed)	14.9 (14)	1.0
SE (Free)	8.5 (14)	0.5 (0.2– 1.3)
Design	77.8 (21)	20.0 (6.2–68.1)
<b>The quality of my chair should be higher.</b>		
SE (Fixed)	13.8 (13)	1.0
SE (Free)	12.2 (20)	0.9 (0.4– 2.0)
Design	74.1 (20)	17.8 (5.7–58.4)
<b>My work space should be better.</b>		
SE (Fixed)	29.8 (28)	1.0
SE (Free)	20.1 (33)	0.6 (0.3– 1.1)
Design	81.5 (22)	10.4 (3.3–35.1)
<b>I need better working conditions, specifically work hours.</b>		
SE (Fixed)	29.8 (28)	1.0
SE (Free)	37.2 (61)	1.4 (0.8– 2.5)
Design	48.1 (13)	2.2 (0.8–5.7)
<b>Other working conditions and the environment for my computer work need to be better.</b>		
SE (Fixed)	9.6 (9)	1.0
SE (Free)	7.3 (12)	0.8 (0.3–2.0)
Design	7.4 (2)	0.8 (0.1–4.2)
<b>I have no complaints about my working conditions or the environment in which I do my computer work.</b>		
SE (Fixed)	17.0 (16)	1.0
SE (Free)	18.3 (30)	1.1 (0.5–2.3)
Design	0.0 (0)	–

**Table 5 Comparison of selected psychosocial conditions among different types of work.**

	SE (Fixed)	SE (Free)	Design
<b>Responsibility for work</b>			
Serious	38.3 (36)	44.5 (73)	29.6 (8)
Appropriate	55.3 (52)	50.0 (82)	66.7 (18)
Not serious	6.4 (6)	5.5 (9)	3.7 (1)
<b>Volume of work</b>			
Too much	47.9 (45)	61.3 (100)	37.0 (10)
Appropriate	45.7 (43)	35.6 (58)	59.3 (16)
Too small	6.4 (6)	3.1 (5)	3.7 (1)
<b>Speed at which I have to work</b>			
Fast	55.3 (52)	65.9 (108)	55.6 (15)
Appropriate	42.6 (40)	30.5 (50)	40.7 (11)
Slow	2.1 (2)	3.7 (6)	3.7 (1)
<b>Pressure to gain PC skills</b>			
Intense	53.8 (50)	65.0 (106)	40.7 (11)
Not very intense	44.1 (41)	34.4 (56)	59.3 (16)
Little pressure	2.2 (2)	0.6 (1)	0.0 (0)
<b>Pressure from deadlines</b>			
Always	45.7 (43)	63.4 (104)	33.3 (9)
Sometimes	51.1 (48)	34.1 (56)	44.4 (12)
No	3.2 (3)	2.4 (4)	22.2 (6)
<b>Time for thinking things over</b>			
Good enough	8.5 (8)	0.6 (1)	7.7 (2)
Fair	58.5 (55)	50.3 (82)	53.8 (14)
Not enough	33.0 (31)	49.1 (80)	38.5 (10)
<b>Support from senior staff or colleagues</b>			
Easy to ask	57.4 (54)	42.1 (69)	44.4 (12)
Not easy to ask	7.4 (7)	14.6 (24)	7.4 (2)
Neither	35.1 (33)	43.3 (71)	48.1 (13)
<b>Checking e-mail messages during non-work hours</b>			
Several times a day	19.1 (18)	24.4 (40)	18.5 (5)
Once a day	34.0 (32)	25.6 (42)	7.4 (2)
Never	29.8 (28)	36.6 (60)	48.1 (13)
Unable to check	17.0 (16)	13.4 (22)	25.9 (7)

technology (IFMA, 2004), has listed 5 vital prerequisites for introducing a free address system.

1. The office is under a lot of pressure to reduce costs.
2. The office has introduced flexible working hours or performance-based evaluations.
3. The proportion of workers permanently in the office is very low.
4. The office has an advanced information network infrastructure.
5. The office has established a very clear office management strategy.

From the viewpoint of occupational safety and health, all the above conditions are obviously stressful for workers. Cost containment requires workers to be more productive; the use of performance-based evaluations forces workers into competition with each other; psychological support from colleagues and seniors is likely to be weak in an office where workers are frequently out; rapidly developing information technology requires workers to gain further computing skills. It naturally follows that stressful conditions like these will affect both workers' mental and physical health.

The results of Study 2 appear to support the above hypothesis. Systems engineers using the free address system tended to suffer from more serious psychosocial problems, and the prevalence of subjective symptoms was much higher than that experienced by systems engineers using the fixed address system. Notably, the very high proportion of very burned out individuals in the population of free address system users was striking.

Of course, it does not mean that the free address system on its own causes stressful conditions. We have to take into account the duties and responsibilities of systems engineers as well as the corporate culture in which they work. The free address system itself is not a risk factor but it might be considered as a risk marker for mental health. An office which satisfies the prerequisites of a free address system might already embody potential risks for workers' health. Those who are in charge of office management, therefore, should adopt a free address system very cautiously. It is essential to carry out a risk assessment prior to its introduction and to formulate a clear policy and plan to manage any identified risks.

**Table 6 Odds ratios for subjective symptoms among system engineers using the free address system and designers against system engineers using the fixed address system.**

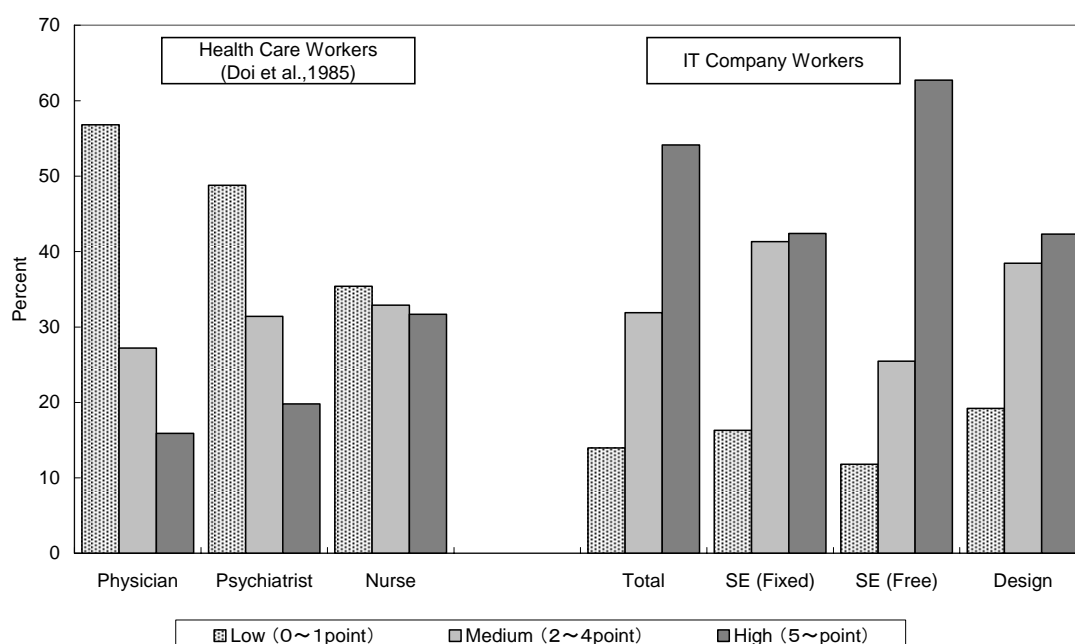
	Prevalence of symptoms (n)	Odds Ratio	95% Confidence Interval		
Pain in/fatigue of eyes					
SE (Fixed)	56.4 ( 53)	1.00			
SE (Free)	59.1 ( 97)	1.12	0.65	–	1.93
Design	74.1 ( 20)	2.21	0.79	–	6.41
Eyesight is failing					
SE (Fixed)	37.2 ( 35)	1.00			
SE (Free)	34.8 ( 57)	0.90	0.51	–	1.57
Design	44.4 ( 12)	1.35	0.52	–	3.49
Leg or foot pain/stiffness					
SE (Fixed)	6.4 ( 6)	1.00			
SE (Free)	7.9 ( 13)	1.26	0.43	–	3.88
Design	7.4 ( 2)	1.17	0.15	–	7.08
Neck or shoulder pain/stiffness					
SE (Fixed)	50.0 ( 47)	1.00			
SE (Free)	61.6 (101)	1.71	0.99	–	2.97
Design	59.3 ( 16)	1.45	0.56	–	3.79
Back or lower back pain/stiffness					
SE (Fixed)	28.7 ( 27)	1.00			
SE (Free)	36.6 ( 60)	1.43	0.80	–	2.57
Design	44.4 ( 12)	1.99	0.75	–	5.23
Arm, hand or finger pain					
SE (Fixed)	7.4 ( 7)	1.00			
SE (Free)	9.1 ( 15)	1.25	0.46	–	3.54
Design	7.4 ( 2)	0.99	0.13	–	5.76
Physical or mental fatigue					
SE (Fixed)	30.9 ( 29)	1.00			
SE (Free)	47.6 ( 78)	2.03	1.15	–	3.60
Design	33.3 ( 9)	1.12	0.41	–	3.04

## 5. Acknowledgements

The authors thank Ms. Tomoko Iwamura for her technical assistance.

## 6. References

- IFMA (International Facility Management Association). (2004). *What is FM?* Retrieved March 29, 2004, from <http://www.ifma.org/whatsfm/definition.cfm?actionbig=9&actionlil=168>
- Pines, A.M., Aronson, E., & Kafry, K. (1981) *Burnout, from tedium to personal growth*. New York, NY: The Free Press.
- Munakata, K., Inaoka, F., Takahashi, T., & Kawano, M. (1988). In T. Doi (Ed.), *Burnout: mental health for physicians, nurses and teachers*. Tokyo, Japan, Kongo Shuppann. [In Japanese: Moetsuki Shôkôgun, Ishi, Kangofu, Kyôshi no Mentaru Herusu.]



**Figure 4 Distribution of Burnout Score among Different Types of Work.**